Science Explains Many Tragic Mysteries of the Air

How Three Little Canals in Each of Our Ears Keep Us Balanced and Cause Airmen to Fall by Making Them Believe They Are Still Moving in a Certain Direction When Really They Are Not

THE mystery of many tragic accidents to aviators resulting from inexplicable failure of the flying men to control their machines at critical moments has now been cleared up by medical science.

On each side of our heads, within the middle ear, closely connected with the apparatus of hearing, there is a curious little series of three hollow loops or membranes. These are called the semi-circular canals because of their shape and also because they are filled with liquid.

In these canals is our sense of balance. On them depends our ability to keep erect or to sway against external movements and to transmit the sensation of balance or our direction in space to our brains. It is through the functioning of these canals that we are able, for instance, to "brace ourselves" when a train in which we are standing strikes a curve, for without them we would have no sensation of being at an uncomfortable angle.

The semi-circular canals are, in fact, the spirit levels of the body, and it is by the impressions they send to the brain that the motor centres send instructions to the proper groups of muscles to keep the body in proper equilibrium against the force of gravity.

It is the proper functioning of these spirit levels in the aviator's ears that enables him to control the delicately balanced machine in which he flies and the conduct of which is so dependent upon the delicacy and trueness of perception of its changes in angle by its driver.

When the spirit levels of the semi-circular canals fail to respond promptly or are misled into thinking—if it can be said that organs really think, and some scientists believe that they do—that the flying machine has a movement or an angle different from what it really has that disaster occurs to the pilot. How is this centre of our sense of balance misled? That question is answered by Dr. Lewis Fisher, major, and Dr. H. W. Lyman, captain in the Medical Corps of the United States army. Both of these scientists have long been on duty at the great aviation camp at Mineola, Long Island, and have had the best opportunity for observation possible. They give the results of these observations in the Journal of the American Medical Association.

The semi-circular canals are filled with a liquid called endolymph, and in this endolymph float a great number of almost microscopically small hard bodies called otoliths, literally ear stones. The canals and the bulb to which they are attached are close beside, indeed, almost a part of, the actual centre of hearing in the ear, which is a shell-like body called the cochlea. The two together are termed the bony labyrinth of the ear. There is one, of course, in each ear. But although so close together the functions of the semi-circular canals and the cochlea are entirely separate.

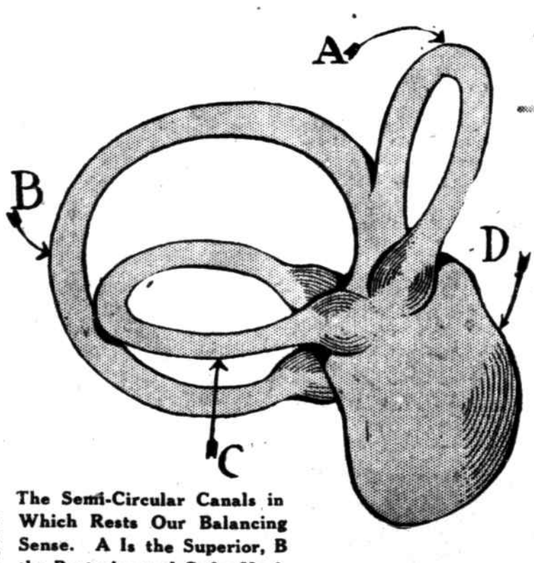
The reactions to sound of the cochlea are carried through the auditory nerve to the brain, but the reactions to gravitation or direction in space of the body possessing it is not carried through this same nerve by the canals. Science, indeed, has not yet discovered just how the impressions do go from the canals to the brain, but however transmitted they are transmitted very thoroughly. Vertigo, with its nausea and other unpleasant symptoms, is caused by the functioning of these canals probably more than by any other factor.

It appears that when the head is turned or bent a movement is set up in the liquid within the semi-circular canals which is transmitted to the otoliths. It is supposed that these otoliths swinging against the sides of the canals touch upon the nerves there and communicate the sensation of movement through them to the brain.

When one is whirled about suddenly and violently or for any length of time the movements of the lymph and otoliths continue in the ears in the same direction in which they have been proceeding. When this happens we have exactly the same sensation of movement that we have been experiencing, although at the time all movement has ceased. This is why after a long rock in a rocking chair one gets up and feels as though she were still rocking. It also explains why people who have had long, rough sea voyages for some considerable time afterward experience the sensation of walking on an unstable earth. All this is due to the fact that the liquid and little stones in the canals have not yet quieted down.

And in the violent movements which aviators must experience, especially in "stunt flying," this is doubly true.

Here, say Drs. Fisher and Lyman, is the explanation of the mysterious falls. The air pilot is moving at a terrific speed; fractions of minutes, and even fractions of seconds, are as important to him as hours are to people walking on solid earth. Coming out of some violent evolution the movement in the spirit levels persists, his brain becomes confused, he misjudges angles and position, grasps the wrong control and crashes to earth and death.



The Semi-Circular Canals in Which Rests Our Balancing Sense. A Is the Superior, B the Posterior and C the Horizontal Loop. Each of These and Their Bulb, D, Is Filled With a Fluid and Almost Microscopic Hard Particles That Give the Brain Perception of the Body's Angle.

By vizualizing the position of the pilot as he is whirled in the various stunt evolutions, it was found that by reproducing a similar whirling in a chair balanced on subjective effects of the actual stunt.

Established facts or principles, the doctors wrote, are the following:

"1. In each ear we have three semicircular tubes, or canals, containing fluid, so placed that they are at right angles with one another. Because of this arrangement, no change of position of the individual is possible without producing some movement of fluid in one or more of the canals. Movement of the fluid in these canals sends messages to the brain, which are there interpreted as body movement. Hence, the ears constitute the motion-sensing organs of the body.

"2. When an individual is whirled, be it in the laboratory or in an aeroplane, there is produced a circulation of this fluid in certain definite canals and planes. Now, if the turning is suddenly altered or stopped, or if the aeroplane comes out of a rotating manoeuvre, the fluid in the canals continues to move in its former plane by sheer force of its momentum. The circulation of the fluid by momentum is interpreted by the brain as body movement; but not being in accordance with fact, the body having ceased to revolve, it constitutes vertigo or dizziness, and is disturbing to the individual.

"Labyrinthine vertigo, therefore, is a false sensation of motion similar to the visual illusion of motion observed when one is watching a moving train from the window of a stationary coach, both being unavoidable phenomena of normal special sense mechanisms which, however, the subject easily learns to disregard.

"One must not fall into the error, however, of thinking that the lack of a normal ear mechanism would be advantageous to the flier, because of the immunity to vertigo which this condition would confer. The absence of such an essential organ as a motion-perceiving apparatus is too great a handicap to the man travelling in an 'air medium' to justify him even in thinking for a moment that he could dispense with it for the sole benefit of vertigo immunity, especially since the normal individual can acquire such an immunity without much difficulty.

"There are three cardinal angles or positions or vertigo, it seems—horizontal, frontal and sagittal. These angles are illustrated by the diagram of the three heads at the bottom of this page.

"The greatest usefulness of the knowledge that 'stunting' is an ear problem lies in the fact that the flier may be educated to disregard the vertigo effects of his 'stunts' in the laboratory, instead of among the clouds, and without danger acquire a tolerance to evolutions to a degree impossible in the air. This can be accomplished by the use of an otologic apparatus known as the 'orientator.' In its construction it is like the cockpit of an aeroplane suspended in concentric rings, after the manner of a ship's compass. The movements—or changes of position—which are possible in all directions except actual forward progression, are governed by the individual seated in the machine, using a set of controls resembling those of an aeroplane."

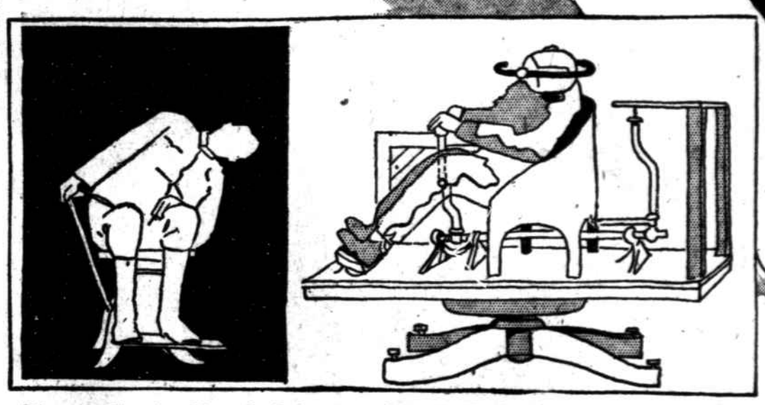
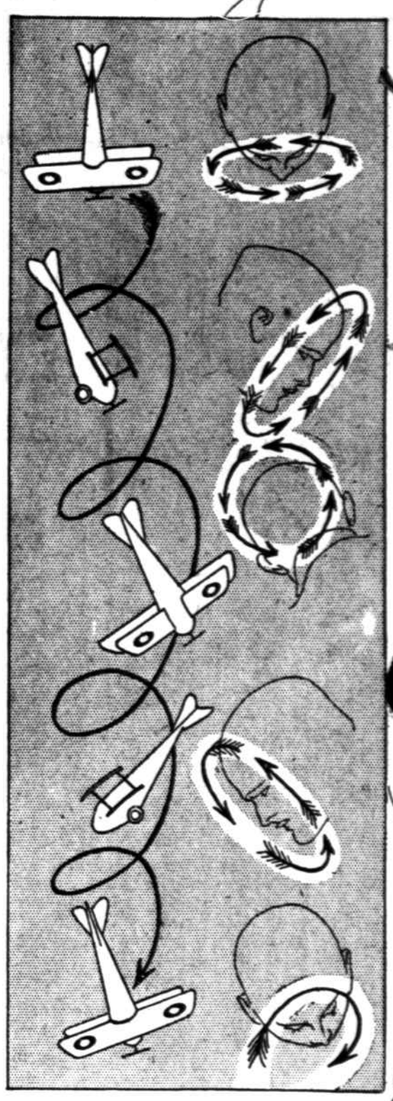
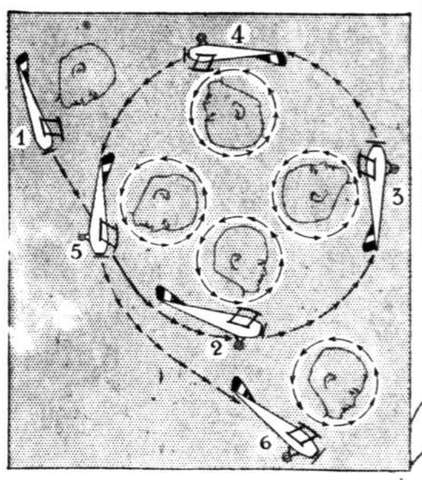


Diagram Showing How the Laboratory Chair Is Used to Simulate the Movements of What Is Known Among Aviators as the "Tight Spiral."



The Mechanism of "the Loop," Showing the Various S gittal Positions of the Head the Flyer Assumes.

The Spinning Nose Dive, in Which the Aviator's Head Is Whirled Both Vertical and Horizontally.



The Three Angles of Movement Through Which the Head of the Aviator Passes. First, the Frontal Motion; Second, the Horizontal; Third, the Sagittal, or from Back to Front Movement.

How an Aeroplane Makes a "Nose Dive," Illustrating the Abnormal Positions of the Aviator During the Process, Which Are Registered by the Semi-Circular Canals in the Aviator's Ears, and Whose Safety Depends Solely Upon Their Accurate Functioning.